

Lesson 7 Overview



DRIVING QUESTION: *How has human activity changed Earth's temperature in the last 150 years?*



LEARNING GOAL:

- Students construct a scientific explanation about how carbon dioxide concentration in the Earth's atmosphere and temperature have changed over time answering the scientific question, "How has human activity changed Earth's temperature in the last 150 years?"



TOTAL TIME: 150 minutes (50 minutes on rate and how it relates to carbon dioxide, 50 minutes on historical events, discussion of homework with introduction and follow-up is 40 minutes)

LESSON SUMMARY: The goal of this lesson is to engage students in thinking about living things in the world around them, where they are found, and how they interact with other living things. Students first read a Discovery News article about how climate change is expected to impact the distributions of species. Then they are oriented to a field exploration where they collect observations (data) on local organisms (Part 1). They then complete their field exploration either in their schoolyard or a local nature area (Part 2).



MATERIALS:

- *Poster Paper*
- *Markers*

BEFORE YOU BEGIN LESSON 7:

Part 1

	You may wish to familiarize yourself with the “Introduction To Rates” exercise and consider whether it will be useful in your classroom. If you feel your students are already familiar with calculating and interpreting rates, you can skip these activities.
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Part 2

	Watch the “The Truth About Climate Change” video (http://www.youtube.com/watch?v=S9ob9WdbXx0) and consider how you will explain the evidence presented. This video shows change in temperature over the last 100 years. In the last scene, David Attenborough claims that the steep rise in global temperature is due to human activity. What evidence does the movie rely on to support this claim?
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You may wish to introduce rates of change in greenhouse gas (carbon dioxide) emissions in the last few hundred years with these videos:

- Time-lapse history of human global CO₂ emissions. This video is a time-lapse history of how human global carbon dioxide emissions have changed on Earth since 1758.
<http://www.youtube.com/watch?v=kqV-kx2CIXU>
- Time history of atmospheric CO₂. This video shows annual variation in carbon dioxide in the Earth’s atmosphere since 1980.
<http://www.youtube.com/watch?v=H2mZyCblxS4&feature=related>
- 300 Years of FOSSIL FUELS in 300 Seconds. This is an excellent illustrated history of human fossil fuel use in the last 300 years. This video will help students fill out the table of human carbon dioxide emission changes over time.
<http://www.youtube.com/watch?v=cJ-J91SwP8w>.
- Monitoring Climate Change. A concluding video that illustrates scientists are monitoring climate changes: <http://news.discovery.com/videos/news-monitoring-climate-change.html>

Part 1: Types of Rate Change

Students begin this lesson by reviewing information on rates of change in graphs. They do this offline in their student notebooks, as shown below.



Lesson 7 Part 1: How has human activity changed Earth's temperature in the last 150 years?

Types of Rate Change

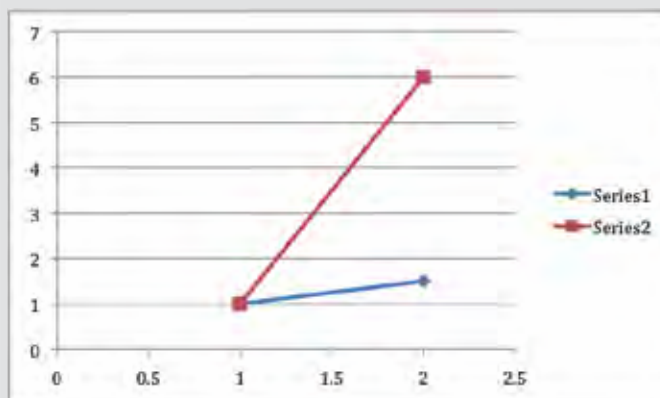
In this activity you will explore how human activity has increased greenhouse gas emissions in the past 150 years, focusing on a particular greenhouse gas - carbon dioxide. But before we do this we must learn about rates. Turn to page 15 of your student notebook to learn about rate types.

How do you think about rates? Some examples of rates that you are probably familiar with are miles per hour in a car, or liters of water per minute in a shower. The higher the number, the faster the car is going or the faster you are using water. Rates show you how quickly something is changing.

In this activity you will explore how human activity has increased greenhouse gas emissions in the past 150 years, focusing on a particular greenhouse gas - carbon dioxide. But before we do this we must learn about rates. Some examples of rates that you commonly encounter are miles per hour in a car or liters of water per minute in a shower. The higher the number, the faster the car is going or the faster you are using water. Rates show you how quickly something is changing.

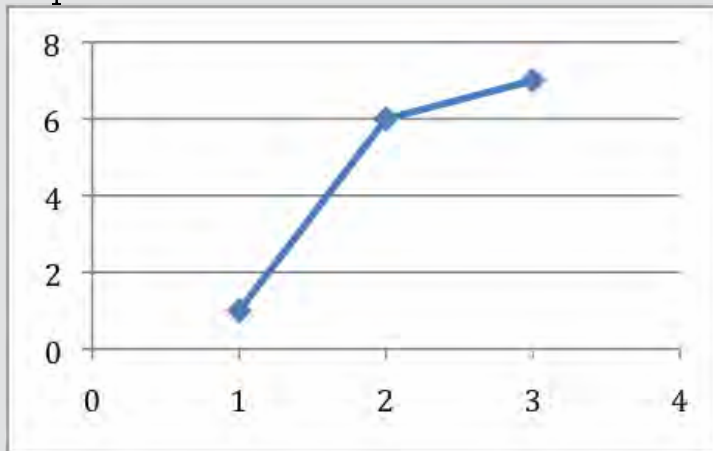
Look at the Graph 1a, below. This shows two different rates of temperature change. The line in blue has a less steep slope, so it is indicating a relatively slow rate of change. The red line has a steeper slope, which indicates a faster rate of change.

Graph 1a



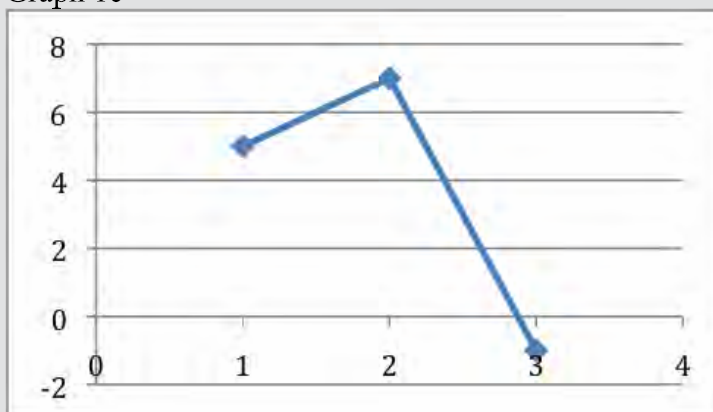
Here's what the graph would look like (Graph 1b) if the temperature went up quickly at first and then continued to increase, but at a slower rate. Scientists would say that this graph indicated a high rate of temperature increase followed by a lower rate of temperature increase.

Graph 1b



Graph 1c shows what it would look like if temperature increased slowly and then decreased rapidly. How would you describe the temperature rate change in this graph? (Hint: use a similar format to the answer for the first graph.)

Graph 1c

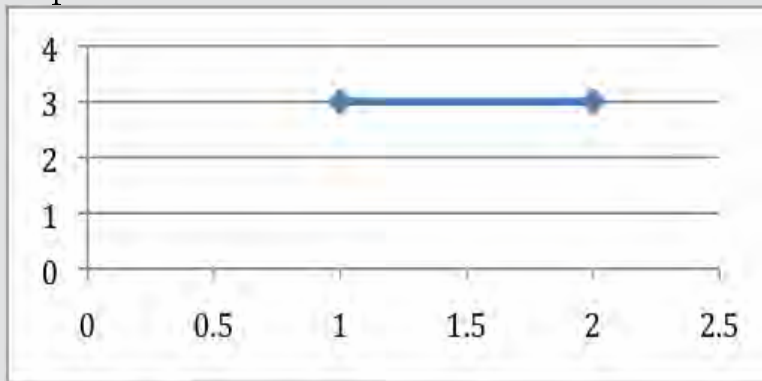


Graphs of temperature change (rate) are generally described in five ways:

- Increasing quickly
- Decreasing quickly
- Increasing slowly
- Decreasing slowly
- Remaining constant.

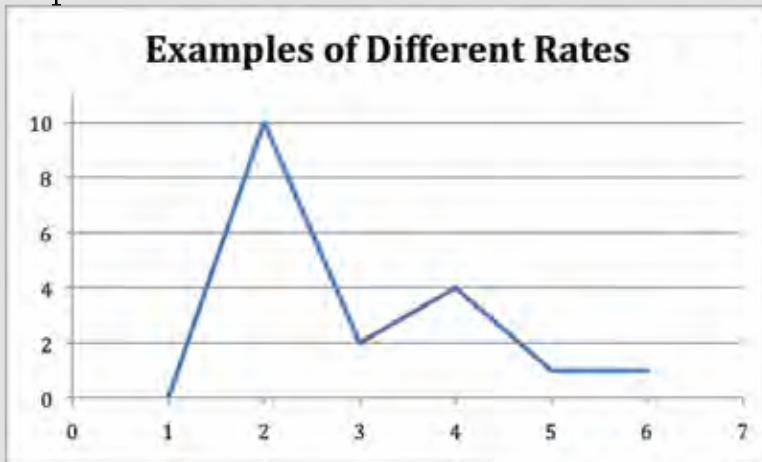
Graph 1d (below) shows an example where the rate of temperature change is constant.

Graph 1d



You can see all five types of rate (in order) in Graph 1e:

Graph 1e



Part 2: Temperature Change Through Time

Have students watch the “The Truth About Climate Change” video (<http://www.youtube.com/watch?v=S9ob9WdbXx0>). Watch the video beforehand and consider how you will explain the evidence presented. This video shows change in temperature over the last 100 years. In the last scene, David Attenborough claims that the steep rise in global temperature is due to human activity. What evidence does the movie rely on to support this claim? Probe your students for two responses.

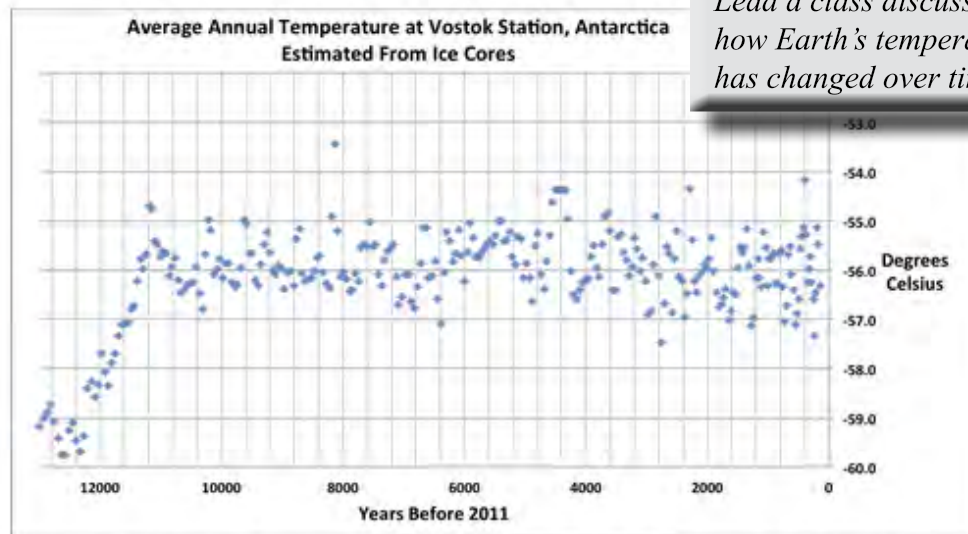
Lesson 7 Part 2: Temperature Change Through Time

Watch this video, called “The Truth About Climate Change”: [excerpt from The Truth About Climate Change](#).

What do you think the lines on the graph in the video represent? Write your answer here:

Average global temperature over time. There are different lines, one is observed temperatures, one is if temperature were explained only by natural causes, one is taking into account human influence.

Take a look at Graph 2 of the average annual temperature on Earth in the last 12,000 years (since the end of the last glacial period). Graph 2 is based on different types of oxygen gas bubbles that have been trapped in ice. Scientists can determine the temperature of an area based on the ratio of different types of oxygen (oxygen isotopes) that are captured by the ice.



Lead a class discussion on how Earth's temperature has changed over time.

Graph 2. Past surface temperatures at the Vostok site in Antarctica, calculated from ice core samples.

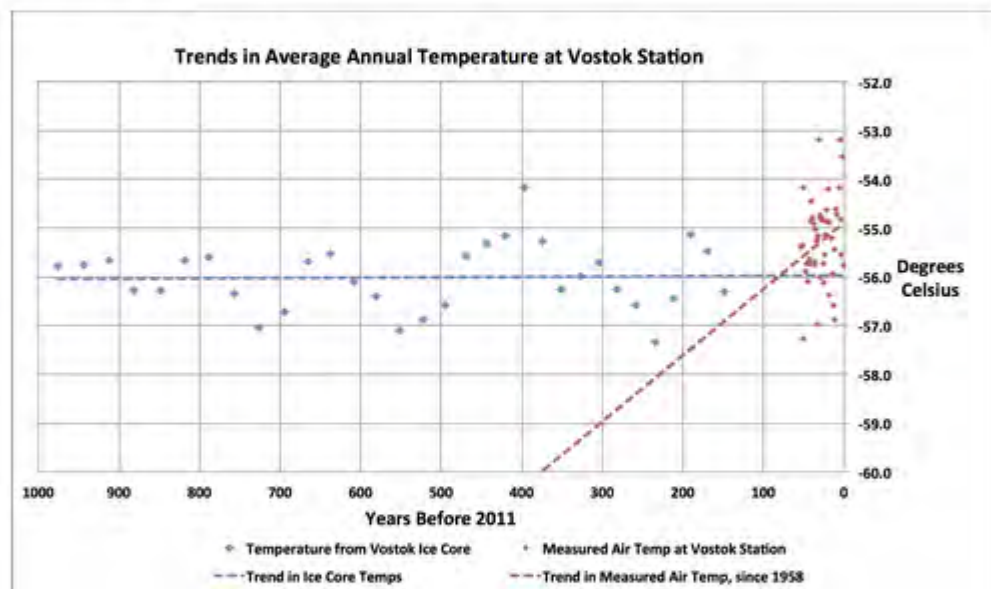
You can see that the average annual temperature on Earth rose rapidly from about 12,000 years ago to about 10,000 years ago, when it stabilized and stayed mostly the same until recently.

Part 2: Temperature Change Through Time

Remind students what a trend line is. A trend line should have the same number of dots above and below the line.

Now look at Graph 3 of the actual **average** annual temperature on Earth in the last 150 years. This graph includes the historical **data** from 1000 years ago until 150 years ago (blue dots) and adds data for the last 60 years (red dots). On this graph we've included the actual, statistically calculated trend for the older, historical data (blue line) and one for more recent data (red line).

How has Earth's temperature changed through time? The data in Graph 3 represents the actual average annual temperature on Earth in the last 150 years. It includes the historical data from 1000 years ago until 150 years ago (blue dots), and adds data for the last 60 years (red dots). It also includes the actual, statistically calculated trend line for the older, historical data (blue line), and one for the more recent data (red line).



Graph 3. Trends in annual average surface temperatures at Vostok Station, Antarctica. Blue dots show past temps calculated from ice core measurement. Red dots show average temps calculated from actual air measurements.

Think about the temperature **data** from 1000 years ago to now. Do **natural climate** cycles explain increases in **global temperature** in the last 150 years?

No, it looks like the recent increase in global temperature is much different than you would expect with just natural cycling.



Part 2: Temperature Change Through Time

Have students create a wall-size classroom graph where they can plot temperature change through time, including the historical events in that accompanied these changes.

Plot on your classroom graph of temperature change through time the various historical events listed below. You will need to do some research to determine the exact year when these events occurred.

Next, indicate in the chart how each event changed global carbon emissions and global temperature (Hint: think about relationship between carbon dioxide and temperature).

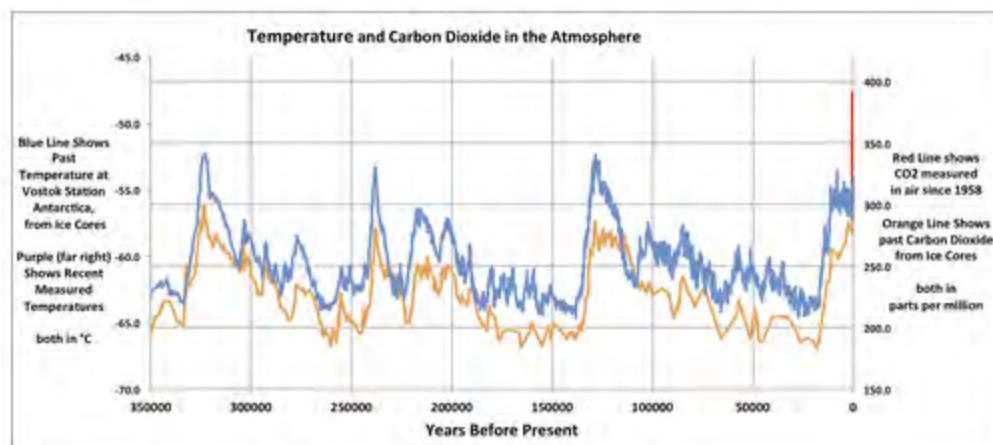
Historical Event	How did carbon emissions change? (Decreased quickly, decreased slowly, remained constant, increased slowly, increased quickly)	How did the global temperature change? (Decreased, neutral, increased slowly, increased much)
Humans start to use fire to modify habitats (frequent burning to improve grazing and clear fields).		
Large numbers of humans transition from gathering/hunting to agriculture.		
Forests of Europe are mostly cleared.		
Forests of eastern North America are mostly cleared.		
Invention of industrial steam engines.		
Large scale use of coal as fuel		
Invention/application of the diesel engine.		
Start of large scale use of electricity in industry/homes.		
First mass-produced automobiles.		
Large scale use of petroleum as fuel.		
Large scale use of methane (natural gas) as fuel.		
Industrialization of cement production.		
Invention of chemical fertilizers.		

Part 2: Temperature Change Through Time

We have seen that temperatures in the past 150 years are different from other times in Earth's history. You already determined that recent increases in temperature cannot be explained by natural variations. Let's begin to figure out what is causing the recent, rapid increase in Earth's temperature. We will do this by comparing events in history to changes in carbon emissions and global temperature. Turn to page 18 of your student binder for instructions on this activity.

Now compare your classroom temperature timeline with the historical events to Graph 4, below. This graph shows two trends over the last 35,000 years on Earth.

The blue line is the average global temperature on Earth and is the same data that you have seen in previous graphs. It is based on the ratio of oxygen isotopes from gas bubbles captured in ice cores. The orange line shows the concentration of carbon dioxide in the Earth's atmosphere. These data are also from gas bubbles captured in ice cores, but scientists measured the amount of carbon dioxide in the gas bubbles, rather than the ratio of oxygen isotopes. The small, red line shows the amount of carbon dioxide in the Earth's atmosphere from 1958 until the present day.



Graph 4. Temperatures and global carbon dioxide levels.

Describe the relationship between the average temperature on Earth and atmospheric carbon dioxide concentration. Write your answer here:

Earth's average temperature shows a very similar pattern to carbon dioxide concentration in the atmosphere.



Part 2: Temperature Change Through Time

Lead a discussion about the carbon emissions impact of each historical event. To conclude the lesson, discuss the relationship between the temperature timeline, the events in human history, and Earth's temperature and atmospheric carbon dioxide levels. Students use this information to answer the following scientific question.:



Think about the relationship between the temperature timeline, the events in human history, and Earth's temperature and atmospheric **carbon dioxide** levels. Use this information to answer the following **scientific question**:

Scientific Question: *What effect has human activity had on temperature change in the last 150 years?*

My Explanation

Claim:

Hint

Human activity has increased the Earth's temperature in the last 150 years.

Reasoning:

Hint

Humans have increased the amount of carbon dioxide in Earth's atmosphere, which increases Earth's temperature.

Evidence:

Hint

1. Burning fossil fuels increases carbon dioxide in the atmosphere, which increases temperature through the greenhouse effect.
2. Data on recent change in Earth's temperature show that increasing temperature is not explained by natural variation in climate.

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